External Exam Motility Alignment

6

Ocular Motility Examination

In an ocular alignment and motility examination, the patient is tested for three principal properties of the visual system: eye movement (motility), binocularity (fusion), and eye alignment. Because the subject is complex, this chapter begins with a discussion of commonly used terminology and basic extraocular muscle function before addressing specific examination techniques for assessing motility, binocularity, and alignment.

Strabismus Terminology

Strabismus is a general term used to describe a misalignment of the eyes in which both eyes are not directed at the object of regard. The Greek word *strabismus* means to squint, to look obliquely or askance, and in some countries other than the United States the terms *strabismus* and *squint* are used interchangeably. Strabismus can either cause or be caused by the absence of binocular vision. Strabismus can also be caused by or may lead to amblyopia.

Amblyopia is a term used to describe a loss of vision. In physiologic terms, amblyopia represents a failure of visual connections from disuse or inability to form a clearly focused retinal image during the first few years of life, considered to be a critical period in the development of the visual pathways. Neither amblyopia nor strabismus causes learning disabilities, although both may co-exist with learning disabilities.

Strabismus is measured with prisms and quantified in prism diopters. An ophthalmic prism is a wedge of clear plastic or glass with a triangular cross-section having an apex and a base (see Chapter 5). Prism power is measured by the number of centimeters of deflection of a light ray measured 1 m from the prism and abbreviated as PD (for prism diopters) or by the superior delta symbol ($^{\Delta}$). The notation PD or $^{\Delta}$ is appended to the numeric measurement of the deviation. Plastic prisms and prism bars are calibrated according to the angle of minimum deviation, whereas glass prisms are calibrated according to Prentice's rule. This affects the way that prisms must be held when measuring the angle of deviation, as described below. Refer to a more detailed text for a discussion on the different ways of calibrating prisms.

A number of terms are used to classify strabismus and describe the characteristics of the direction of the deviating eye. Over the years, various authors have promoted their favorites, and there is now confusion and disagreement regarding the correct terminology. Strabismus is called *comitant* (or concomitant or nonparalytic) when the angle of misalignment is approximately equal (eg, all measurements are within 7^{Δ} of each other) in all directions of gaze. Strabismus is called *incomitant* (or noncomitant, nonconcomitant, paralytic, or restrictive) when the angle of misalignment varies with the direction of gaze.

Strabismus is further classified as either a heterophoria or a heterotropia. A *phoria* (or *heterophoria*) is a latent tendency toward misalignment that occurs only when binocularity is interrupted. During binocular viewing, the two eyes of a patient with a heterophoria are perfectly aligned. The term *strabismus* usually refers to a *tropia* (or *heterotropia*), a manifest deviation that is present when both eyes are open

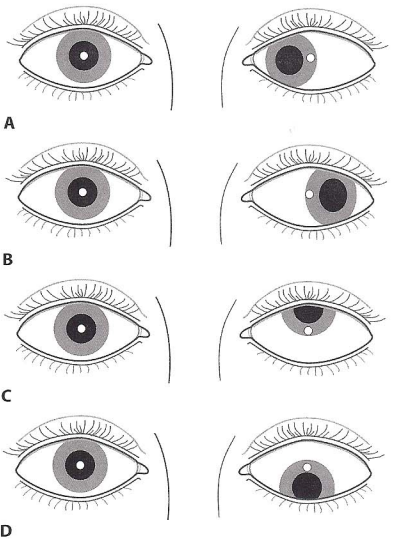


Figure 6.1 Types of heterotropia. Top to bottom: esotropia; exotropia; hypertropia; hypotropia.

(Figure 6.1). A heterotropia that is present only part of the time is called *intermittent*, whereas one that is always present is called *constant*. A heterotropia that shifts from one eye to the other is called *alternating*. If only one eye turns, the tropia will be further designated as left or right, respectively.

Heterotropias and heterophorias are subdivided according to the direction of the deviation. *Esotropia*, a manifest strabismus in which the visual axis is deviated toward the nose, is the most common type of ocular misalignment of childhood. *Exotropia*, in which the eye deviates outward toward the temple, is more likely to be intermittent than esotropia. An eye that deviates upward is called *hypertropic*. Currently there is disagreement regarding appropriate notation in this situation. By convention, the eye that deviates upward is noted and, therefore, a vertical deviation is referred to as a right or left hypertropia according to the higher eye, whether or not that eye is the one used for fixation.

Table 6.1 Types of Heterophoria and Heterotropia

Prefix	Name of Disorder		Description
	-phoria (latent)	*-tropia (manifest)*	
eso-	esophoria	esotropia	inward deviation
exo-	exophoria	exotropia	outward deviation
hyper-	hyperphoria	hypertropia	upward deviation
hypo-	hypophoria	hypotropia	downward deviation

In reality, if the patient uses the higher eye to fixate, the fellow eye will be *hypo*tropic but the term *hypotropia* is not usually used. Table 6.1 summarizes the types of heterophorias and heterotropias. Table 6.2 lists clinical abbreviations commonly used in the evaluation of strabismus.

Motility Terminology

Eye movements can be monocular (one eye only) or binocular (both eyes together). Monocular eye movements are called *ductions*, and six terms are used to describe them:

- *Adduction* (movement of the eye nasally)
- *Abduction* (movement of the eye temporally)
- *Elevation* (sursumduction; movement of the eye upward)
- *Depression* (deorsumduction; movement of the eye downward)
- *Intorsion* (incycloduction; nasal rotation of the superior vertical corneal meridian)
- *Extorsion* (excycloduction; temporal rotation of the superior vertical corneal meridian)

Binocular eye movements are described as versions and vergences. *Versions* are normal binocular eye movements in the same direction (eg, to the right, to the left, etc). One muscle in each eye is primarily responsible for the movement of that eye into a particular field of gaze. These two simultaneously acting muscles are called *yoke muscles*, and their movement is said to be *conjugate*, that is, they work at the same time to move the two eyes in the same direction. For example, the right medial rectus and the left lateral rectus work together to move

Table 6.2 Clinical Abbreviations Used in Evaluation of Strabismus

Mechanical Position of the Eyes	
Esodeviations	
E	esophoria for distance
ET	esotropia for distance
E(T)	intermittent esotropia for distance
E' or ET' or E(T)'	esodeviations for near
Exodeviations	
X	exophoria for distance
XT	exotropia for distance
X(T)	intermittent exotropia for distance
X' or XT' or X(T)'	exodeviations for near
Hyperdeviations	
H	hyperphoria for distance
HT	hypertropia for distance
H(T)	intermittent hypertropia for distance
H' or HT' or H(T)'	hyperdeviations for near
Ortho	no deviation present
Extraocular Muscles	
IO	inferior oblique
IR	inferior rectus
LR	lateral rectus
MR	medial rectus
SO	superior oblique
SR	superior rectus
Other Abbreviations	
DVD	dissociated vertical deviation
IPD	interpupillary distance
NPA	near point of accommodation
NPC	near point of convergence
OA	overaction
PD	prism diopter *or* pupillary distance (meaning is clear from context)
UA	underaction

the eyes to the left. The six positions of gaze in which yoke muscles act together, known as the *cardinal fields of gaze*, are right and up, right, right and down, left and up, left, and left and down.

Vergences are normal, disconjugate binocular eye movements in which the eyes move in opposite directions. The two primary types of vergences routinely evaluated are *convergence*, the movement of both eyes nasally, and *divergence*, the movement of both eyes temporally.

Function of the Extraocular Muscles

There are seven extraocular muscles: four rectus muscles, two oblique muscles, and the levator palpebrae superioris muscle. The recti and obliques move the globe, whereas the levator primarily moves the eyelid and only indirectly affects ocular motility. The relative positions of the extraocular muscles are shown in Figure 6.2.

The medial rectus and the lateral rectus muscles have only horizontal actions. The medial rectus muscle performs adduction and the lateral rectus performs abduction. The superior rectus and the inferior rectus muscles insert into the globe from a more lateral position and hence provide more complex motility action. The primary action of the superior rectus is elevation; its secondary actions are adduction and intorsion (incycloduction). The primary action of the inferior rectus is depression; its secondary actions are adduction and extorsion (excycloduction).

The oblique muscles, as their name indicates, come around the globe at an oblique angle to provide motility. The superior oblique muscle passes through the trochlea, a cartilaginous pulley located on the superonasal orbital rim, before inserting in the posterosuperior quadrant of the globe. The primary action of the superior oblique

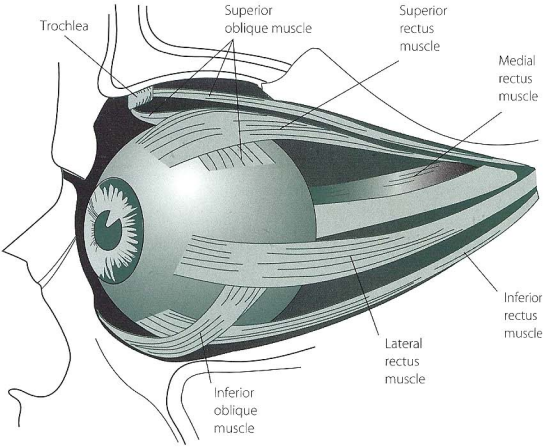


Figure 6.2 The extraocular muscles and the trochlea.

muscle is intorsion; secondarily it provides depression and abduction. The inferior oblique inserts posterolaterally on the globe near the macula. Its primary action is extorsion, and secondarily it provides elevation and abduction.

Table 6.3 summarizes the basic actions of the extraocular muscles; Figure 6.3 diagrams the paired yoke muscles in each eye that are primarily responsible for movement into the cardinal fields of gaze.

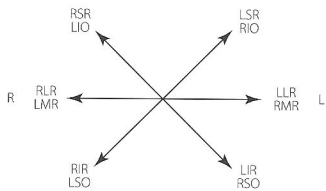


Figure 6.3 The cardinal positions of gaze and the yoke muscles acting in those positions.

Table 6.3 Actions of Extraocular Muscles

Abducted Position	Primary Position	Adducted Position
Superior rectus		
1. Elevation	Elevation	Adduction
2.	Adduction	Intorsion
3.	Intorsion	
Inferior Rectus		
1. Depression	Depression	Adduction
2.	Adduction	Extorsion
3.	Extorsion	
Superior Oblique		
1. Intorsion	Intorsion	Depression
2. Abduction	Depression	
3.	Abduction	
Inferior Oblique		
1. Extorsion	Extorsion	Elevation
2. Abduction	Elevation	
3.	Abduction	
Medial Rectus		
1. None	Adduction	Adduction
Lateral Rectus		
1. Abduction	Abduction	None

Ocular Motility Examination

Taking a careful and complete history is essential in the examination of a patient suspected of having strabismus. As the history is being taken, the examiner has the opportunity to observe the patient in a relaxed, casual manner. Particular attention should be paid to the presence of any unusual head position or movement, noting the direction of the movement or position and whether it manifests as a head tilt or a face turn. It is also important to note any tendency of the patient to partially or completely close one or both eyes. Be watchful for light sensitivity (photophobia), or ask the patient about it.

The examiner should obtain information about the birth history and subsequent development of the patient, especially if the patient is a child. Areas of particular interest regarding a child include a history of prematurity, rubella, or seizures. Also obtain information regarding any medications currently being used, or that were used by the mother during pregnancy. It is important to document the age of onset of the strabismus (old photographs can be invaluable in this regard), as well as whether it is constant or intermittent; whether it is present at distance or near or both; whether it is alternating or unilateral; whether it is most evident when the child is tired or ill; and whether there has been any history of treatment by patching, glasses, or surgery. In the case of an older patient, information should be obtained about frank diplopia, the patient's general health, and any history of trauma or medical problems such as diabetes or thyroid disease. In all cases, the examiner should ask about any family history of strabismus or amblyopia.

If the patient is being seen for a routine examination, visual acuity and external examination may be done before motility is evaluated. If, however, the patient is being seen specifically for motility evaluation and strabismus is suspected, tests of binocularity should be performed before any dissociative examinations (ie, tests that would require occluding one eye).

After the history and general inspection, the examiner should perform an initial, gross screening of ocular movements, as described in Clinical Protocol 6.1. The phrase *diagnostic positions of gaze* is applied to the composite of these gaze positions or movements. The positions of gaze are referred to as follows:

- *Primary position* (straight ahead)
- *Secondary positions* (straight up, straight down, right gaze, and left gaze)

- *Tertiary positions* (the four oblique positions of gaze: up and right, up and left, down and right, and down and left)
- *Cardinal positions* (up and right, up and left, right, left, down and right, down and left)
- *Midline positions* (straight up and down from the primary position)

The presence of any *nystagmus* (involuntary rhythmic eye jerks) should be noted. Latent (occlusion) nystagmus (LN) is a congenital, conjugate, horizontal jerk nystagmus that occurs under monocular viewing conditions. In this condition, when one eye is occluded (as is done for cover testing) nystagmus develops in both eyes, with the fast phase directed toward the covered eye. Binocular vision is usually tested next, when possible.

The deviation in alignment is checked and quantified by means of the corneal light reflection test and/or the cover tests with the use of prisms. At this point, the patient's dominant eye can also be determined. To check for ocular dominance, a fixation object is held at approximately 50 cm in the midplane in front of the patient. The object is moved steadily toward the patient until one eye loses fixation and turns out. The eye that is able to maintain fixation is the dominant eye. Ocular dominance is additionally confirmed by determining the *near point of convergence* (see Clinical Protocol 4.4). The normal near point of convergence is between 6 cm and 10 cm and is relatively independent of patient age.

Accommodative convergence of the visual axes occurs as part of the near reflex. A fairly consistent increment of accommodative convergence (AC) occurs for each diopter of accommodation (A), and the relationship can be expressed as the accommodative convergence/accommodation (AC/A) ratio. The normal AC/A ratio is 3^{Δ} to 5^{Δ} of accommodative convergence for each diopter of accommodation. Abnormalities of this ratio are common and are an important cause of strabismus. If the AC/A ratio is abnormally high, the excess convergence tends to produce esotropia during accommodation, or focusing on near targets. If the AC/A ratio is abnormally low, the eyes will tend to have an exodeviation when the individual looks at near targets. Two techniques of measuring the AC/A ratio are described in Clinical Protocol 6.2, but for other methods and for a more detailed discussion of the clinical implications of this interrelationship, refer to comprehensive texts such as the resources listed at the end of this chapter.

Tests of Alignment

The most commonly used methods of assessing and quantifying ocular alignment are the red reflex (Bruckner) test, corneal light reflection test, and cover tests. Corneal light reflection tests are typically used with patients who have poor fixation or who are unable to cooperate sufficiently for cover testing. Cover tests are chosen when the patient is able to cooperate and to fixate with each eye on a target so that accommodation can be controlled.

Red Reflex Test

The red reflex test, also referred to as the Bruckner test, is the most rapid but the least sensitive test for detecting strabismus. It is particularly useful to screen for strabismus. It is performed by using the direct ophthalmoscope, with the bright white light and the lenses set to zero,

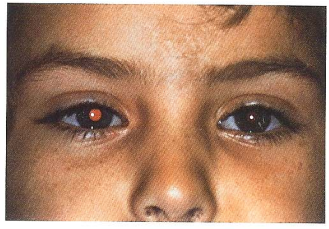


Figure 6.5 The red reflex test. This child has an esodeviation, as evidenced by the lighter, brighter reflex in the nonfixating eye.

to obtain a red reflex simultaneously in both eyes. If strabismus is present, the deviated eye will have a lighter and brighter reflex than the fixating eye (Figure 6.5). This test will also identify opacities in the visual axis and moderate to severe anisometropia.

Corneal Light Reflection Test

The corneal light reflection test compares the position of the corneal light reflection in both eyes. In normally aligned eyes, the reflections should be symmetric on the two corneas and in the same position relative to the pupil. Observation of the corneal light reflection constitutes an objective assessment of ocular alignment. For newborns and very young children, this may be the only feasible way of testing for strabismus. The two most common methods of performing the corneal light reflection test are Hirschberg's method and Krimsky's method.

Hirschberg's method

Hirschberg's method, usually performed on infants under 1 year of age, gives a good estimation of ocular alignment by directly analyzing the angle of decentration of the corneal light reflection. Figure 6.6 illustrates estimated deviations, and Clinical Protocol 6.3 describes how to perform the corneal light reflection test using Hirschberg's method. The method is based on the fact that every millimeter of decentration is equal to roughly 7°, or 15$^{\Delta}$, of deviation off the visual axis. A light reflection at the pupillary margin (2 mm from the pupillary center) is equal to approximately 15° (30$^{\Delta}$) deviation; a reflection in the middle of the iris indicates a deviation of about 30° (60$^{\Delta}$); and a reflection at the limbus is equivalent to a deviation of 45° (90$^{\Delta}$).

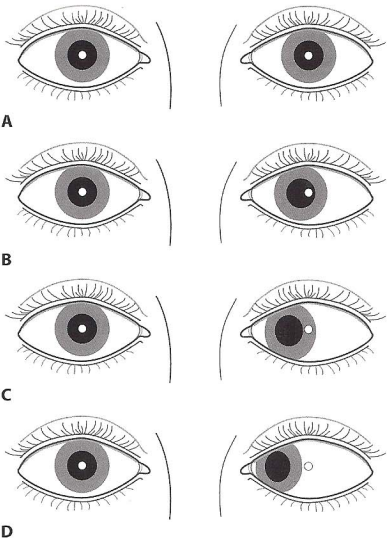


Figure 6.6 Hirschberg's method of performing the corneal light reflection test to estimate deviation. **(A)** Normal alignment. **(B)** 15° esotropia. **(C)** 30° esotropia. **(D)** 45° esotropia.

Krimsky's method

Krimsky's method utilizes reflections from both corneas and is the preferred approach for assessing ocular deviation in a patient with poor vision in the deviating eye. Reflections from both eyes are produced by an appropriately placed penlight fixated by the patient's better eye. Prisms of increasing or decreasing power are placed in front of the fixating eye until the corneal reflection is centered in the deviating eye (Figure 6.7). Because of differences in prism power calibration, plastic prisms should be held with the rear surface in the frontal plane to achieve approximately the desired effect. Glass prisms should be held with the rear surface perpendicular to the eye's visual axis. The modified Krimsky's method of performing the corneal light reflection test is summarized in Clinical Protocol 6.4.

Clinical Protocol 6.1

Assessing the Ocular Movements

1. Sit facing the patient. Hold your finger or a small fixation target at eye level about 10 to 14 inches in front of the patient, with the patient looking in primary position (straight ahead).
2. Ask the patient to follow the target as you move it into the six cardinal fields and up and down along the midline. Elevate the upper eyelid with a finger on your free hand to observe down gaze.
3. Note whether the amplitude of eye movements is normal or abnormal in both eyes. Rate the amplitude for all fields of gaze by considering normal amplitude to be 100%, and rate lesser amplitudes accordingly. To record the relative underaction or overaction, designate the normal as 0, that is, no overactions or underactions are present. Use the numeral 4 to designate maximum underaction or overaction. Underactions thus are rated from –1 to –4, while overactions are rated from +1 to +4.
4. Note any nystagmus that may be present, and record the nystagmus according to its presence, direction, and amplitude in any field of gaze where applicable.

Clinical Protocol 6.3

Performing the Corneal Light Reflection Test, Hirschberg's Method

1. Have the patient seated facing you with head straight and eyes directed in primary gaze.
2. Hold a penlight in front of the patient's eyes at a distance of approximately 2 feet, directing the light at the midpoint between the two eyes of the patient. Align yourself with the light source. Instruct the patient to look directly at the light.
3. Compare the position of the two corneal light reflections and record the estimated result as prism diopters or degrees of deviation. Make a notation in parentheses beside the measurement: (by Hirschberg).

Clinical Protocol 6.5

Performing the Cover-Uncover Test

1. Have the patient look at a distance fixation target, and position yourself directly opposite the patient, within arm's reach.
2. Swiftly cover the fixating eye with an occluder or your hand, and observe the other eye for any movement. Carefully note its direction.
3. Uncover the eye and allow about three seconds for both eyes to be uncovered.
4. Swiftly cover the other eye and observe its fellow for any movement.
5. Ensure that the patient is maintaining fixation on the same point as established for step 1.
6. After an interval of about a second, uncover the eye and observe it for any movement.
7. Note results but do not record them until other cover testing is completed.
8. Repeat the test for near, using a near fixation point.
9. Repeat the distance and near tests using the patient's habitual refractive correction, if applicable.

Clinical Protocol 6.6

Performing the Alternate Cover Test

1. With the patient seated upright and looking at a distance fixation point, rapidly shift the occluder from one eye to the other several times, not allowing any interval of binocularity. The examiner should be seated slightly to the side of midline, facing the patient and at arm's length to the patient.
2. Place a trial prism over one eye (usually the patient's dominant eye), while continuing to shift the cover from one eye to the other. Remember to orient the prism with the apex toward the direction of deviation. Choose the strength of the initial trial prism to approximate the deviation estimated by the position of the corneal light reflections.
3. Continue to place prisms of progressively higher power in front of the eye until no movement is noted in either eye (neutralization). Additional prisms may be introduced until a *reversal* of movement is noted. The use of both horizontally and vertically placed prisms is often necessary to completely neutralize the shift.
4. Record the results as noted in the examples in Table 6.4; in addition you may diagram the results in the various diagnostic positions of gaze (see examples in Figure 6.9).
5. Repeat the test for near.

Head and Face

Obtain different perspectives of the person's head and face, beginning at a talking distance and then proceeding to closer inspection and magnified views. A sketch or photograph of the patient's face can be made to document any abnormalities. Measuring the occipitofrontal circumference of the head with a tape measure, along with other growth measurements such as height and weight, helps to assess children with developmental delay.

Inspect the face for symmetry and craniofacial bone development, looking for evidence of old trauma, clefting syndromes, and hemifacial atrophy. Following this, evaluate the mobility of the facial muscles. Any suspected motor or sensory abnormality is tested by special techniques (Clinical Protocol 9.1). Corneal sensation can be tested at this time, if it is necessary.

Inspect the facial skin for dermal and vascular changes. Observe the skin's color, texture, tone, and moisture. A magnifying lens such as the +20 D condensing lens used in indirect ophthalmoscopy, the direct ophthalmoscope, 2×–3× binocular loupes, and low magnification with the slit-lamp biomicroscope can help in assessing individual skin lesions. Common skin abnormalities are classified by the most distinctive characteristic (Table 9.2). The distinguishing attributes of skin abnormalities that should be noted are size, elevation, color, margination, depth of involvement, distribution, surface changes, and degree of tissue destruction.

Lymph nodes are normally not visible or palpable. Gross enlargement of any node should be noted. The examiner may palpate for preauricular and cervical lymph nodes before inspecting other external features, particularly when considering infection, granulomatous disease, or malignancy.

Examine the inside of the mouth and nose with a penlight to look for changes in the oral and nasal mucous membranes. Note whether the parotid or other salivary glands are enlarged or tender.

Sinus examination is feasible if the light source is very bright and the room is completely dark. To examine each frontal sinus, point the transilluminator upward through the supraorbital ridge while covering the orbit with your hand. To examine each maxillary sinus, point the transilluminator downward behind the infraorbital rim and look into the patient's open mouth and through the palate to see the glow of light from clear, air-filled sinuses.

Eyelids

Evaluate the symmetry and relative position of the eyebrows. Check to see whether there is any compensatory lifting or wrinkling on one side compared with the other. Note the position of the eyelashes relative to the globe, the number or density of the lashes, and their color. Note the position, movement, and symmetry of the eyelids, including the presence of any scars from previous surgery or injury.

Specific abnormalities of the lids and lashes are described, drawn, or photographed for the medical record. Shining a transilluminator through the eyelid can help differentiate a solid from a cystic lid mass. Table 9.3 lists common eyelid abnormalities.

With the eyelids open, the upper eyelid usually hides the top 1.5 mm of the cornea. The lid creases (palpebral sulci) of the upper and lower eyelids divide the lid skin into adherent tarsal portions and loosely attached preseptal portions. The lower lid crease (inferior palpebral sulcus) is more evident in the young. The nasojugal and malar folds of the lower lid become more prominent with aging. Table 9.4 lists many normal adult values relative to eyelid structure and function.

To assess eyelid closure, ask the patient to blink and then to gently close both eyes. Normal lid movements are necessary for the lacrimal pump to draw tears into the puncta, canaliculi, and lacrimal sac. Any gap that allows exposure of the ocular surface (ie, lagophthalmos) is noted and measured.

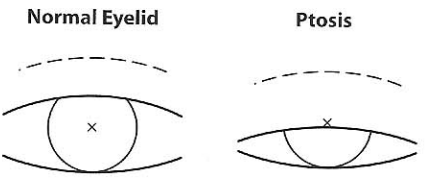
Table 9.3 Common Abnormalities of the Eyelids, Eyelashes, and Eyebrows

Abnormal Eyelid Position or Function	
Lagophthalmos	Insufficiency or weakness of eyelid closure
Blepharospasm	Involuntary contraction of the orbicularis oculi muscle
Blepharoptosis	Abnormal drooping of the eyelid (owing to congenital, mechanical, myogenic, aponeurotic, or neurogenic causes)
Protective ptosis	Drooping of the upper eyelid (owing to ocular surface discomfort or inflammation)
Pseudoptosis	An eyelid that appears to sag (owing to contralateral lid retraction, a small or displaced globe, or an overhanging brow)
Brow ptosis	Drooping of the eyebrow
Ectropion	Outward turning of the eyelid margin (owing to involutional, cicatricial, or paralytic causes)
Entropion	Inward turning of the eyelid margin (owing to involutional, cicatricial, or spastic causes)
Lid lag	Delayed movement of the upper lid during downward pursuit of the eye, often associated with lid retraction
Abnormal Eyelashes or Eyebrows	
Trichiasis	Misdirection of one or more eyelashes
Madarosis	Patchy or diffuse loss of eyelashes
Poliosis	Whitening of lashes
Distichiasis	Extra row of eyelashes
Synophrys	Confluent eyebrows that meet in the midline
Abnormal Eyelid Fold	
Dermatochalasis	Redundant eyelid skin
Blepharochalasis	Chronic lymphedema with wrinkled eyelid skin
Epicanthus	Vertical fold at the medial canthus
Epiblepharon	Horizontal fold near the lower eyelid margin

Eyelid position relative to the cornea is estimated by observing the position of the upper and lower eyelid margins relative to the superior and inferior corneal limbus, respectively. Judging the margin–limbus distances is useful for screening. For any patient with blepharoptosis, the examiner must measure interpalpebral fissure height, upper lid margin–corneal reflex distance, upper lid crease position, and levator function. These steps

Table 9.4 Normal Adult Values of Eyelid Structure and Function

Blinking rate	15–16 blinks per minute
Palpebral fissure length	25–30 mm
Palpebral fissure height	8–12 mm
Distance from upper lid margin to corneal light reflex	3.5 mm
Distance from upper lid margin to upper lid crease	8–11 mm
Levator excursion	8–15 mm



Interpalpebral fissure height	10.5 mm	3 mm
Upper lid margin–corneal reflex distance	+4 mm	-1 mm
Upper lid margin–upper lid crease distance	8 mm	10 mm
Levator function	15 mm	10 mm

Figure 9.4 Method of recording ptosis measurements.

are outlined in Clinical Protocol 9.5. Figure 9.4 illustrates the method of noting the results of these measurements in the medical record. The degree of blepharoptosis is graded as listed in Table 9.5.

Upper eyelid retraction is assessed with the patient's gaze in the primary position by noting where the upper lid margin crosses the globe in relation to the superior limbus. Lid retraction is classified as listed in Table 9.6. Patients with lid retraction may also exhibit lid lag (von Graefe sign), which is a delayed or fluttering lid movement on downward pursuit.

To detect lower lid retraction, first have the patient fixate a target, such as your finger. While you look at the eye you suspect to be affected, have the patient follow your finger as you move it downward until the lower lid margin of the patient's other eye rests at the lower limbus. Observe whether any sclera shows between the lid margin and limbus of the involved eye, an indication of lid retraction.

Table 9.5 Method of Grading Degree of Upper Eyelid Blepharoptosis

Severity	Interpalpebral Fissure Height	Margin–Reflex Distance
Mild	7 mm	+1.5 mm
Moderate	6 mm	+0.5 mm
Severe	5 mm	−0.5 mm

Table 9.6 Method of Grading Degree of Upper Eyelid Retraction

Severity	Upper Lid Margin Position
Mild	Lid margin intersects the upper limbus
Moderate	Up to 4 mm of sclera of the superior globe is visible
Severe	More than 4 mm of sclera shows

Lacrimal System

Observe the lacrimal gland by raising the patient's upper lid and instructing the patient to look downward and medially, thereby prolapsing the palpebral lobe. The orbital lobe is sometimes palpable at the superotemporal orbital rim. Observe and note any lacrimal gland masses (see also "Lacrimal System" under "Palpation" later in this chapter).

Observe the lacrimal puncta for apposition to the globe and patency. Look for punctal eversion, stenosis, functional obstruction by redundant conjunctiva, and occlusion. Inspect the area of the lacrimal sac for swelling and erythema. Note whether there is an overflow of tears.

Globe

To examine the entire ocular surface and sclera, hold the eyelids open and ask the patient to look up, down, right, and left. Twirling a cotton applicator at the upper and lower lid creases helps to raise and lower the lids and avoids direct touching of the lids or globe with the fingers. This technique is described in Figure 9.5.

The volume of the tear meniscus should be assessed by inspection. Indicator paper can be used after a chemical injury to check the tear pH.

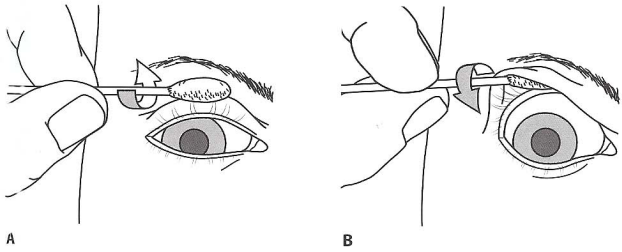


Figure 9.5 No-touch technique for raising upper eyelid. **(A)** Apply a cotton-tipped applicator to skin of upper eyelid at the lid crease as the patient looks down. **(B)** Twirl the applicator stick between the thumb and forefinger to bunch up the excess lid skin and elevate the upper lid margin, then elevate the lid skin by raising the applicator stick toward the superior orbital rim.

Inspect the bulbar conjunctiva. Note the type and extent of any conjunctival discharge and classify it as watery, serous, mucoid, or purulent.

The palpebral conjunctiva is first examined inferiorly. Ask the patient to look up while you gently pull the lower lid downward. Evaluate the tarsal conjunctiva, normally about 3–4 mm wide at its central portion, and as much of the remaining lower palpebral conjunctiva as possible. To expose the upper tarsal conjunctiva, evert the upper lid as the patient looks down. Several techniques for lid eversion are presented in Clinical Protocol 9.6. The central upper tarsus is normally 9–10 mm wide, and the overlying tarsal conjunctiva generally is the best place to evaluate conjunctival papillae and follicles. Exposure of the retrotarsal conjunctiva and upper fornix may require the use of an eyelid retractor.

Examine the anterior globe in sufficient ambient lighting. Subtle color changes of the conjunctiva (eg, icterus) and the sclera (eg, age-related hyaline plaques at the insertion of horizontal rectus muscles) are better seen with the naked eye in natural sunlight than with slit-lamp illumination. One or more intrascleral nerve loops are often present, usually 4 mm from the superior limbus.

Measurements of the corneal diameter, when needed, are usually obtained with a millimeter ruler, although calipers and gauges give a more accurate reading. The observer must sight exactly perpendicular to the ruler to avoid parallax error. The horizontal corneal diameter is about 10 mm in the newborn and reaches the adult length of 11–12 mm by 2–3 years of age. The vertical diameter is more difficult to assess

because the exact location of the superior and inferior limbus is harder to define. The corneal diameter is measured in patients suspected to have a developmental disorder of the globe.

Better ways than gross inspection are available to evaluate corneal topography, but a quick look from the patient's side, aligning your view along the iris plane, helps to discern severe ectasia, as in keratoconus. Another way to detect a corneal deformity is to look at the contour of the lower eyelid border as the patient looks down. For example, Munson's sign is the angular curvature of the lower lid produced by keratoconus. The retinoscope and direct ophthalmoscope can also be used to detect refractive changes caused by abnormal corneal topography.

The depth of the anterior chamber can be checked during the external examination. Diffuse and narrow-beam penlight techniques for doing so are described in Clinical Protocol 9.7. In the penlight technique, the angle of the anterior chamber is classified by the relative positions of the anterior iris and the posterior cornea (Table 9.7). Gonioscopy is performed whenever an anterior chamber angle abnormality is suspected (see Chapter 11).

Suspected lesions inside the eye can be assessed by using a transilluminator or bright penlight. Clinical Protocol 9.8 describes specific techniques of transscleral illumination and transpupillary retroillumination.

Estimating Anterior Chamber Depth

Flashlight With Diffuse Beam

1. While facing the patient, hold a penlight near the temporal limbus, and shine the light across the front of the right eye toward the nose. Keep the beam parallel to the plane of the normal iris.
2. Observe the medial aspect of the iris. Normally, the iris is completely illuminated (Figure 1A). An eye with a shallow anterior chamber will have two thirds of the nasal portion of the iris in shadow (Figure 1B).

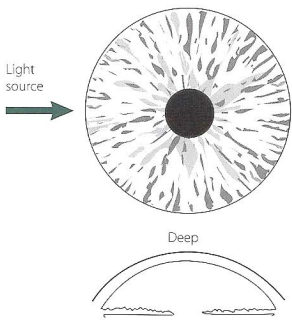


Figure 1A

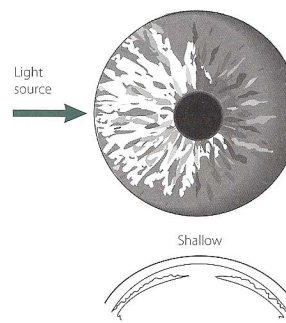


Figure 1B

3. Grade the angle as open (grade IV or III), intermediate (grade II), or narrow (grade I).
4. Repeat the test for the left eye.

Flashlight With Slit Beam

1. Direct the slit beam perpendicular to the peripheral cornea.
2. View the anterior chamber angle at a 60° angle from the beam.
3. Grade the peripheral angle width by comparing the distance between the corneal endothelium and the iris with the corneal thickness. In an open angle, the peripheral chamber depth equals the corneal thickness. When the peripheral depth is one fourth or less of the normal corneal thickness, gonioscopy should be done to evaluate the angle.